DB

EARTHQUAKE INDUSTRIAL STANDARD

OF THE PEOPLE'S REPUBLIC OF CHINA

ICS 91.120.25

P 15

DB/T 59-2015

Technical requirements of instruments in network for earthquake monitoring - Seismic intensity instrument

地震观测仪器进网技术要求 地震烈度仪

Issued on: January 28, 2015 **Implemented on: March 01, 2015**

Issued by: China Earthquake Administration

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Technical requirements of instruments in network for earthquake monitoring - Seismic intensity instrument

1 Scope

This Standard specifies technical requirements and test methods for seismic intensity instrument in network.

This Standard is applicable to design, production, use, maintenance and quality supervision of seismic intensity instrument.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 4208-2008, *Degrees of protection provided by enclosure (IP Code)*

GB/T 6587-2012, *General specification for electronic measuring instruments*

GB/T 17626.5-2008, *Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test*

GB/T 17626.17-2005, *Electromagnetic Compatibility - Testing and measurement techniques - Ripple on d.c. input power port immunity test*

GB/T 17626.29-2006, *Electromagnetic compatibility (EMC) - Testing and measurement techniques - Voltage dips short interruptions and voltage variations on d.c. input power port immunity tests*

DB/T 21-2007, *Technical requirements of instruments in network for earthquake monitoring. The description of common technical parameter and test method*

GJB 101A-1997, *General specification for environmentally resistant quick release small circular electrical connectors*

This Standard uses the following symbols and abbreviations:

E-W: East-west direction

N-S: North-south direction

U-D: Upright direction

FIR: Finite Impulse Response

IIR: Infinite Impulse Response

LTA: Long-Time Average

STA: Short-Time Average

TCP: Transmission Control Protocol

IP: Internet Protocol

FTP: File Transfer Protocol

POE: Power Over Ethernet

NTP: Network Time Protocol

UTC: Coordinated Universal Time

4 Technical requirements

4.1 Acquisition of ground motion signals

The seismic intensity instrument shall have the ability to simultaneously acquire ground motion signals in three directions: E-W, N-S, and U-D.

4.2 Main technical indicators

Main technical indicators of seismic intensity instrument shall meet the requirements of Table 1.

Table 1 -- Main technical indicators of seismic intensity instrument

No.	Item	Technical indicator
1	Acceleration measurement range	-19.6m/s^2~19.6m/s^2 (E-W and N-S) -19.6m/s^2~19.6m/s^2 or -29.4m/s^2~9.8m/s^2 (U-D)
2	Acceleration measurement error	<5% (0.1Hz~20Hz)
3	Linearity error	<1%
4	Frequency band range	Low frequency cut-off frequency: ≤0.01Hz (-3dB)

4.5 Records of observed-measured waveform data

4.5.1 The seismic intensity instrument shall have the function of recording waveform data of E-W, N-S, U-D three-directional seismic events to automatically generate event data files.

4.5.2 The event data files shall include waveform data between 30s before the event trigger time and the end of the event, as well as geographic coordinates of the observation point, site type, installation method, time code, sampling rate and other information.

4.5.3 The storage time for the event data files shall not be less than 3 months.

4.6 Transmission of observed-measured waveform data

4.6.1 When the seismic intensity instrument is at the event triggering, it shall be able to transmit E-W, N-S, U-D three-directional waveform data, including 30s data before the event to the remote server, until the event ends.

4.6.2 The seismic intensity instrument shall have continuous data transmission function to timely transmit E-W, N-S, U-D three-directional acquisition data.

4.6.3 When the seismic intensity instrument is transmitting event data or continuous data, the delay time of the output data shall not exceed 1s.

4.7 Event trigging information transmission

When an event is triggered, the seismic intensity instrument shall use the predetermined server IP address to immediately send the event triggering information to the server, including triggering time, triggering parameters, observation point number, geographical coordinates of the observation point.

4.8 PGA, PGV, intensity value transmission

For the measured instantaneous PGA and PGV values and their measurement time, it shall use the predetermined server IP address to immediately send them to the server. At the end of an event, it shall send final PGA value, PGV value, and instrumental seismic intensity value of the earthquake event.

4.9 Timing protocol

4.9.1 The seismic intensity instrument shall have the ability to synchronize with standard UTC time via satellite timing (compass system, GPS) or network time protocol (NTP). Use UTC time to mark the moment of sampling data. Use UTC time to represent time information that is output in other data.

4.9.2 The synchronization error between the seismic intensity instrument and UTC time shall not be greater than 0.1s.

		Standard acceleration sensor and data collector	Extended uncertainty (k=2) ≤5% (0.1Hz~100Hz)

5.1.2 Test ambient temperature shall be in the range of 15°C~25°C. The relative humidity shall be less than 75%, without strong vibration interference.

5.2 Amplitude-frequency characteristics and acceleration measurement error

5.2.1 Test signal frequency and amplitude

When the sampling rate of the seismic intensity instrument is 50Hz, the frequency of the test signal shall be selected from 1Hz, 5Hz, 10Hz, 15Hz, 19Hz, 21Hz, and 33Hz. When the sampling rate of the seismic intensity instrument is 100Hz, the frequency of the test signal shall be selected from 1Hz, 5Hz, 10Hz, 20Hz, 30Hz, 35Hz, 39Hz, and 65Hz. When the sampling rate of the seismic intensity instrument is 200Hz, the frequency of the test signal shall be selected from 1Hz, 5Hz, 10Hz, 20Hz, 30Hz, 40Hz, 60Hz, 78Hz, and 130Hz.

The effective value of the test signal amplitude shall be selected as $5m/s^2$. If the displacement amplitude of the vibration table is not large enough, it may choose an appropriate acceleration test amplitude at the frequency of 1Hz according to the maximum displacement amplitude limit of the vibration table.

5.2.2 Vertical vibration table test

The seismic intensity instrument to be tested shall be fixed on the vertical vibration table. According to the selected test signal frequency and amplitude, set the parameters of the vibration table in order and start the vibration table to operate. At the same time, set the seismic intensity instrument to record and collect data. Each test frequency point shall record the collected data of not less than 60s.

5.2.3 Horizontal vibration table test

5.2.3.1 The seismic intensity instrument shall respectively conduct the horizontal vibration table test in E-W and N-S directions.

5.2.3.2 When testing, the seismic intensity instrument to be tested shall be fixed on the horizontal vibration table. It shall make E-W (or N-S) direction of the seismic intensity instrument parallel to the vibration direction of the vibration table. According to the selected test signal frequency and amplitude, set the parameters of the vibration table in order and start the vibration table to operate. At the same time, set the seismic intensity instrument to record and collect data. Each test frequency point shall record the collected data of not less than 60s.

5.2.4 Data processing

5.5.1 Selection of test signal

Use sweep signal to test. The sweep signal frequency range is not less than 5Hz~15Hz. The frequency change rate is 1Hz/s. The sweep signal amplitude shall be 5m/s^2.

5.5.2 Test steps

Conduct the test according to the following steps:

a) Fix the seismic intensity instrument and the acceleration sensor on the vibration table at the same time. The analog output of the acceleration sensor is connected to data collector;

b) The data collector adopts standard clock timing. The seismic intensity instrument adopts standard clock, NTP time server or satellite timing receiver;

c) Set sampling rate of the data collector according to sampling rate of the seismic intensity instrument;

d) After the seismic intensity instrument and the data collector are synchronized to the standard time, start the vibration table to output the frequency sweep test signal;

e) Set the seismic intensity instrument to record and collect data. At the same time, record the data collected by the data collector.

5.5.3 Data processing and determination

Conduct data processing according to the following steps:

a) Data interception. Respectively according to the time information in the recorded data of the seismic intensity instrument and the data collector, intercept data for the same time period that contains the frequency sweep signal. The length of the intercepted data segment is not less than 10s;

b) Calculate their cross-correlation;

c) Calculate timing error. Read the number of sampling points where the maximum peak of cross-correlation is off-center. The product of the number of sampling points and the sampling period is the time deviation between the seismic intensity instrument and the data collector, which can be regarded as the timing error test result of the seismic intensity instrument;

d) Determination. The test results shall meet the requirements of 4.9.2.

a) Fix the seismic intensity instrument to be tested and the three-directional standard sensor in parallel on the triaxial drive vibration table. Keep the installation azimuths of them the same;

b) Use the data collector to record the output signal of standard sensor;

c) Use three-directional seismic wave analog signal to drive the triaxial drive vibration table;

d) Check and record the event detection output information of the seismic intensity instrument, the output values of PGA and PGV, and the measured value of instrumental seismic intensity.

5.7.2 Low-frequency vibration table test

Conduct the low-frequency vibration table test according to the following steps:

a) Fix the seismic intensity instrument to be tested on the horizontal vibration table. It shall make E-W or N-S direction of the seismic intensity instrument parallel to the vibration direction;

b) Use seismic wave analog signal to drive the vibration table. It shall check and record the event detection output information of the seismic intensity instrument, the output values of PGA and PGV, and the measured value of instrumental seismic intensity;

c) For each test signal, it shall be tested no less than 3 times;

d) Rotate the seismic intensity instrument to be tested by 30° and 45°. Repeat b) ~ c) steps.

5.7.3 Test data

5.7.3.1 The test data can be generated by multiplying the strong seismic acceleration waveform data recorded by the strong vibration observation station by a gain factor between 0.2~5. For the triaxial drive vibration table, it may directly use the three-directional test data. For the low-frequency vibration table, it may use N-S directional observation data or E-W directional observation data to generate test data. It may also use the synthetic data of two horizontal directions to generate the test data.

5.7.3.2 It shall select the acceleration observation data of different earthquakes and the acceleration observation data of different epicenter distance stations to generate test data.

5.7.3.3 Test data shall not be less than 10 groups. The maximum peak acceleration amplitude shall be selected from different values in the range of $0.2m/s^2$~$10m/s^2$.

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